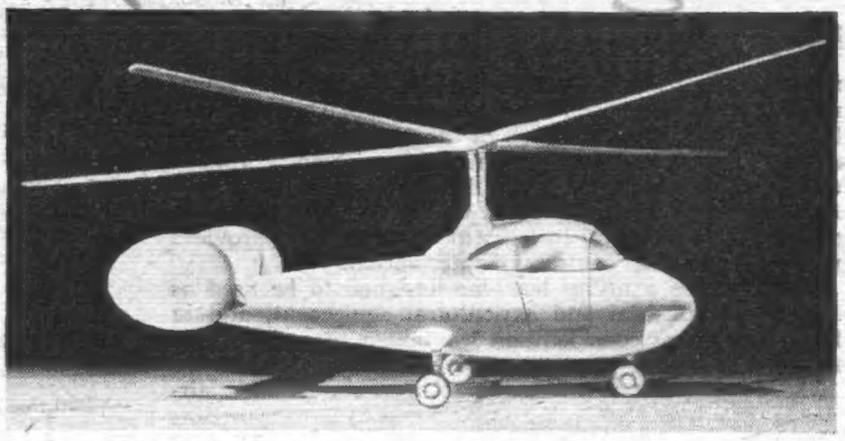
KAMAN K-190

An American Helicopter with Servo-control of Intermeshing See-saw Rotors



This model of the K-190-A shows how the passenger version of the utility machine may look

AMONG the many helicopter configurations now undergoing development trials in the United States, the Kaman K-190 is of particular interest on account of certain unusual features of its rotor system. Put very briefly, this comprises two intermeshing two-bladed rotors, the blades being of the "rigid" type without flapping hinges, the two blades of each rotor see-sawing about a single central hinge instead, as in the single-rotor Bell, to mention a type which is familiar in this country.

Where the Kaman breaks new ground, however, is in the operation of the cyclic pitch of the rotors. There is no bearing for the root of the blades in the rotor hub. Pitch is changed by the somewhat daring expedient of twisting the actual blades between the root and the three-quarter radius station. The K-190 has been under test for a long time, and is at present undergoing a series for the Civil Aeronautics Administration certificate. It had previously completed a 100-hour endurance test on the ground, during which the rotors and transmission were deliberately "thrashed" in order to discover any weak points. Apparently the whole mechanism stood up to the ordeal.

Twisting of the rotor blades requires a considerable force, and the Kaman engineers achieve this by using servo flaps mounted a short distance behind the blades, the pilot controlling the flaps which, in turn, control the blade twist. The system may be likened to an aircraft wing so weak in twist that it gives reversed control. That is to say that a negative angle on the servo flap increases the angle of the main surface and thus increases its lift. That the solution of the problems connected with this form of control was no easy matter will be appreciated when we point out that it took the Kaman engineers two years of theoretical analysis and experimental verification, but the results appear to justify the work. One great advantage, from the pilot's point of view, of the Kaman system is that the control loads on the collective and cyclic pitch sticks are very light, and there is scarcely any feed-back. The most doubtful point seems to be the structural effect of twisting the blades, but the prolonged fatigue tests made appear to have disclosed no weakness after a vast number of reversals. It should be explained here that the blades are made of solid wood, being formed from a block of laminated spruce planks.

Torsion and Flutter

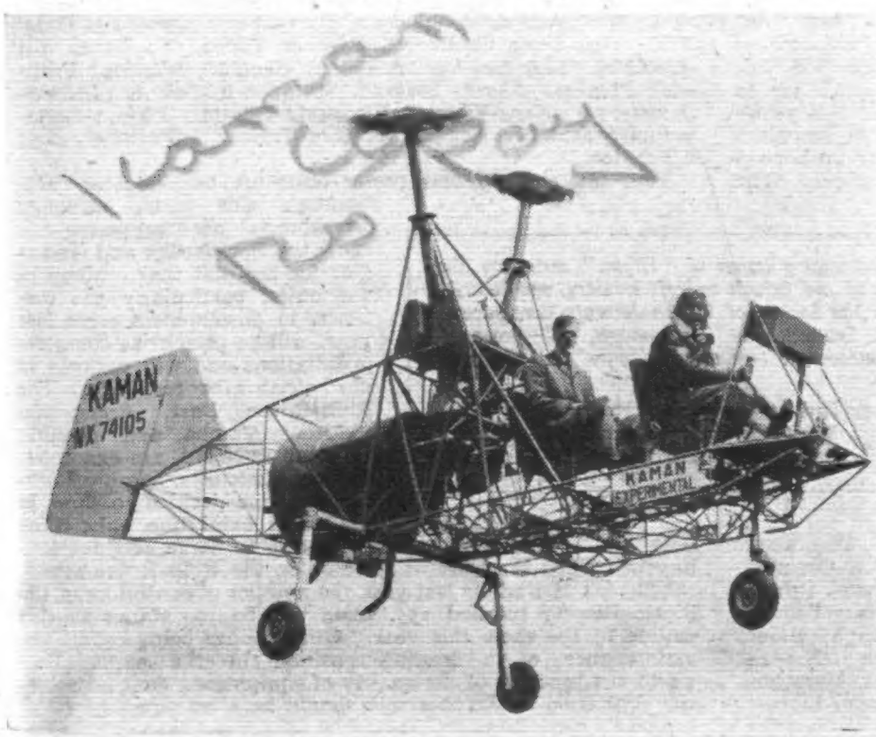
The designers explain that whereas conventionally controlled blades require high torsional stiffness to avoid torsional deflection, the Kaman blades are of low stiffness, both in bending and torsion, and that as a result the machine is smooth and free from vibration. The presence of the servo flap behind the blade is claimed to improve the flutter characteristics, and another advantage of the use of such a flap is that it has been possible to get away from the symmetrical aerofoil section in the blades and to use instead a section of high lift and low drag, thereby achieving a wider operational range before tip stalling sets in at high forward speeds.

Pilot's controls in the Kaman helicopter are conventional, there being a cyclic stick, a collective pitch stick incorporating the throttle, and rudder pedals. By means of a torque tube and push-pull rods the sticks and pedals are connected to the collective pitch forks and gimbal ring assemblies located at the base of the rotor shafts. Control applied to these assemblies is transferred through push-pull rods inside the hollow rotor shafts, through bell cranks at the rotor hub to push-pull rods located in the blade leading edge, and finally through a bell crank in the servo flap bracket to attach directly to the servo flap hinge.

Cyclic control is obtained by tilting the gimbal ring assembly, thereby causing a rocking motion which is carried to the servo flap as the gimbal ring rotates with the rotor.

Movement of the collective pitch stick raises and lowers the two gimbal ring assemblies simultaneously by means of the hinged collective pitch forks. This provides equal pitch increase or decrease to all servo flaps through the full 360 deg sweep of the rotor.

The rudder pedals raise and lower the two gimbal ring assemblies alter-



As it is intended mainly for pest destruction and similar work, accessibility for maintenance was considered of primary importance in the K-190 utility helicopter, hence the open framework.